Doctors, lawyers and building-associated diseases

The differing viewpoints of doctors and lawyers pose problems regarding causality in building-associated diseases

By Michael J. Hodgson, M.D., and Catherine A. Hess
Member ASHRAE

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Emerging legal concerns in indoor air quality

By Susan L. Rose, Ph.D.

Use of the courts to resolve environmental and social issues is a growing trend that must be considered when planning, designing, operating and maintaining indoor spaces. While this legal area is relatively new and liability too often unclear, it is now necessary at the outset for all participants in the process of building design, construction, operation and maintenance to address and minimize the potential for any future legal actions.

The following article is the first of a series that will explore some of these concerns, illustrate recent legal cases, discuss government indoor air quality (IAQ) activities, and outline some solutions for those with a financial and professional interest in IAQ.

These articles resulted from a series of seminars and forums on this topic that began in 1989 at the ASHRAE Winter Meeting in Atlanta. The articles in this series are intended to be informative and provocative, and to encourage IAQ concern as a priority among design professionals. ■

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Buildings have traditionally been considered safe places to work. Still engineers are quite familiar with the engineering liability for building performance. Over the last several years, the threat of liability has also arisen for disease, raising compensation issues for owners, operators and tenants of these buildings. Increasing numbers of complaints have been voiced by occupants.

Although the cause of the "sick building syndrome" was initially considered to be solely decreased ventilation (either because of increased envelope tightness or decreased provision of outdoor air), this is no longer widely considered to be the case. The two primary causes of discomfort appear to be either relatively low levels of volatile organic compounds (VOCs) or microbial agents (spores, molds and fungi). Inadequate ventilation, poor operations and maintenance, and indoor sources of pollutants lead to exposures that generate potential health effects.

Building occupants' complaints may range in subjective severity from trivial to disabling. The decision on severity and medical validity of complaints (impairment) lies in the domain of doctors and scientists. On the other hand, compensation and disability are determined by lawyers, referees and the courts. Legal liability for disease may be ultimately imposed upon the owners, operators or tenants of many of these buildings through third-party lawsuits, raising compensation issues.

Conflicts exist between legal and medical definitions of causal relationships. Accordingly, this article discusses causation issues in the biomedical sciences, along with the criteria for assessing causality. These criteria have developed from review of epidemiological data and from clinical cases.

Legal definitions of causation are then summarized, and several classic approaches to causation in law and medicine are described and contrasted. Finally, several published cases of diseases related to buildings are detailed. Analysis of specific cases will

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help readers understand the process that occurs from the time of initial complaints to an ultimate opinion regarding the work-relatedness of disease.

A medical approach to illness

As people grow older, they develop increasing numbers of complaints with increasing frequencies. Within any two-week period, between 10% to 50% of the population at large will have complaints consistent with some "disease."

Obviously, most individuals do not visit a physician. Mechanic suggested that prospective patients present their complaints to colleagues, at some point hear that these complaints are unusual, and then decide to seek medical help.[1] Therefore, feedback from others may be more instrumental in driving individuals to become patients than the intensity of symptoms or subjective "disease." These others may include family and friends but, more recently, may also include media descriptions of illness.

At some point, patients come to accept that they may have a disease that requires medical intervention. The more credible the reinforcing source (friends, family, media or health practitioners) and the greater the respect the prospective patient has for the reinforcer, the more likely that individual will become a patient. However, the patients' understanding and experiencing of illness are separate from the physicians' understanding of disease and their own beliefs.

In the traditional model of disease and doctor/patient interactions, the patient's responsibility is to get well while the physician's responsibilities are to determine and explain the likely long-term outcome, and treat and heal the patient. Patients visit their physicians with complaints. Physicians attempt to classify the symptoms to some syndrome, allowing them to identify a likely mechanism of disease for which an appropriate test exists. Testing this mechanism allows physicians to determine the presence or absence of the disease in question.

About 60% to 75% of diagnoses can be made on the basis of symptoms alone. Some additional percentage (about 15%) depends on recognizing specific findings during physical examination. Another 5% to 10% require specific laboratory testing. In the remainder, no diagnosis is ever actually established. Therefore, diagnostic tests are not as useful or as necessary as the public generally assumes.

A second misconception is that physicians usually change the natural course of disease. This is often not true. In fact, the primary function of physicians is to support patients, often by precribing medication to make the disease tolerable.

Physicians often do not need diagnostic tests because they easily recognize the disease. For example, upper respiratory tract infections (leading to 500,000 lost workdays per year in America) can be diagnosed without any laboratory tests. Attempts to grow viruses in the laboratory or perform blood tests may be undertaken, but these will usually be considered inappropriate expenses and may not be reimbursed.

On the other hand, when new syndromes emerge or when physicians are confronted with patterns they do not recognize as clearly, they rely much more strongly on tests, even if the scientific accuracy of these tests is less than 100%. Nevertheless, a test may be helpful when applied in a specific situation where there is a reasonable prior probability of a disease being present. The degree of uncertainty that physicians are willing to tolerate results from considering the severity of the disease, the hazard and cost of the diagnostic tests, the costs of the disease, and the consequences of failing to make a different diagnosis.

The certainty with which physicians insist on making diagnoses is defined in medical terms, with medical consequences. For example, when a 50-year-old smoker has severe chest pain, it is often considered appropriate to hospitalize that individual. On the other hand, if a 20-year-old has similar complaints, hospitalization occurs less often.

The seriousness of the intervention, the potential consequences of failure to intervene, and the hazards to which physicians are willing to subject the patient depend on the hazard of the disease and the danger of treatment. The degree of certainty with which physicians pursue a precise diagnosis is in direct relation to the severity of the disease and the danger of the treatment (including changing jobs or residences, with major financial consequences).

Diseases are recognized with greater difficulty when they occur rarely, when the physician has not previously seen similar cases, or when the disease has not been described in the new context in which it is seen. That is, when a prior suspicion (probability) of disease is low, tests may be less useful. For example, a test may not be considered because a disease is thought to be unlikely in a specific situation.

Second, even if a disease is considered and a test ordered, the result may be disregarded. This is because the prior probability is low and the predictive value of the test for the presence of disease is lower than in a high probability situation.

In addition, tests may be falsely negative for several reasons. All tests can be characterized by their receiver-operating characteristic curves, which define the false positive and false negative results. Second, a specific patient may have a disease still in an early stage, so the abnormality measured by that specific test is not yet present.

Finally, getting well depends on additional factors not previously mentioned. In the work setting, several specific risk factors have been identified both for delayed recovery and for early (including too-early) return to work. Job satisfaction, lack of income support, individual culpability and adequate social support are clear predictors of rapid recovery. On the other hand, involvement in unforeseen (though preventable) accidents caused by others tends to lead to delayed recovery. These may be subsumed under the term "illness behavior."

Work-relatedness and causation of disease

Work-related disease. Traditionally, four levels of work-related disease have been defined: unambiguously work-related disease; disease that may be from work or from some other cause; disease to which occupational exposures may have contributed; and pre-existing disease exacerbated by work.

First, some diseases can, by their very nature, be caused only by one specific exposure. These diseases include the dust-induced lung diseases such as silicosis, which does not result from any other cause except prior silica exposure. Work in buildings has never been found to be the sole cause of diseases in this category.

Second, some diseases may be caused either by exposures at work or at home, but they clearly have more than a single cause and they may occur in a variety of settings. For example, asthma is a disease of airways' "twitchiness" after exposure to airborne chemicals or microorganisms. It may exist in an office worker and result from some specific exposure in the office or from a similar specific exposure at home.

Because asthma attacks do not necessarily resolve quickly, symptoms may persist well into the next day, week or even month. Asthma may be due to a specific microorganism that is found both at work and at home. Symptoms may actually occur in both

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places through the same mechanism and each may contribute to disease persistence.

Third, some diseases may exist before the individual enters the workplace and be exacerbated by current exposures. For example, individuals with pre-existing carpal tunnel syndrome might not experience the resulting hand/wrist/elbow pain at work until they are reassigned to a poorly designed workstation.

As another example, asthmatics are more sensitive to low levels of irritant chemicals. Thus, they may have increased symptoms at work without meeting the criteria for a diagnosis of true occupational asthma. Or individuals may have a disease to which more than one factor contributes. Smoking and asbestos exposure for lung cancer is one such example.

Fourth, some intervening illness (unrelated to the work at hand) may require individuals to change the precise nature of their employment. For example, loss of sight through a car accident may make it impossible for a clerk-typist to continue working in a prior job. When disease is considered related to work or affects work performance, the degree of the relatedness must be defined.

In diseases commonly attributed to buildings, specific criteria for work-relatedness may be defined. The list of illnesses with recognizable criteria and definable causes has been presented and discussed in Hodgson.[2] The remainder of this article defines the several techniques used to establish causal relationships in medicine.

Documenting causation. Because physicians have frequently failed to recognize occupational disease when it occurred, the body of knowledge of exposure-effect relationships is substantially lower than even many physicians expect. For example, Disher documented that, in work-related disease, the general diagnosis is actually correctly made, but up to 95% of the true causes are not recognized by the treating physicians as being occupational in origin.[3] Fifteen years later, physicians are still not much better at identifying work-related disease.

Overall, physicians consider three levels of scientific evidence to link a disease with exposures: epidemiology, toxicology and clinical trials.[4] Epidemiology (the study of where and why diseases occur; or the distribution and determinants of disease) is the evidence collected in the practice of medicine and the investigation of large groups of individuals.

Toxicology (the science of poisons) allows the identification of harmful effects of certain substances under controlled conditions. Finally, the practice of clinical medicine, with individual patients, has defined a scientific technique (the n-of-one clinical trial) to link specific effects with specific causes.

In the 1950s, Bradford-Hill and Doll first summarized the criteria now generally used as epidemiologic criteria for causation.[5] This approach is used when large-scale studies of humans have been undertaken, when appropriate measurements of exposure have been obtained, and when several cohorts are available for review.

The criteria themselves include strength (magnitude of the effect), consistency (present in multiple studies or groups), temporality (cause precedes the effect), dose-response relationships (the more exposure, the greater the effect), specificity (few other causes of the effect), and plausibility (a likely mechanism).

Many exceptions can be found for each of these criteria. It is rare for even three or four of them to be seen in one set of studies on a specific topic. In addition, this approach assumes that multiple epidemiologic studies have been performed, which is often not the case. Nevertheless, where epidemiologic criteria are available, they have generally been considered reasonably convincing.

Toxicology (the scientific study of poisons) generally uses living animals, bacteria and fungi, or isolated portions of cells (such as specific proteins), exposes them to controlled amounts of poisons, and measures effects. Fundamental aspects of toxicology include:

- The concept of the critical organ (a specific portion of the body is always affected first);
- Structure-activity relationships (the effect of an agent is substantially predictable on the basis of its molecular structure); and
- Controlled exposure to define a delivered dose (application of the poison in the route that it is toxic—inhaled, eaten, absorbed through the skin, etc.—in amounts likely to be associated with toxic effects, alone or in combination).

For many agents of interest in indoor environments, the mechanisms, necessary doses and the interactions of agents have not been defined.

Where large-scale epidemiologic studies have not been performed, specific agents are uncertain and controlled laboratory experiments are not possible, on-site evaluation of effects may be attempted. A general description of this approach is available in the medical literature.[6,7]

The measurement most likely associated with the health effect of interest is obtained repeatedly, under varying exposure conditions (i.e, at work and at home). Differences can then be identified or patients assured that the most likely adverse health effect is not measurable.

As an example, one can consider whether hypersensitivity pneumonitis (HP) can result from exposure to one of several ventilation systems in a specific building. A case of disease must be established, using standard clinical criteria for diagnosis. Epidemiologic criteria for a causal relationship would be found according the list above, but the cost of such a study (thousands of dollars per patient evaluation), the size of the available population in the building (usually less than 2% to 4% of building occupants have HP), or the lack of prior studies would make it difficult to use epidemiology.

A specific organism could be identified by using toxicologic studies (i.e, animal and bench laboratory models). On the other hand, no generally accepted animal model may exist for the causal agent. Toxicology may then provide no answer.

In the absence of epidemiology or toxicology, physicians must rely on other methods of diagnosing HP in the specific case. Traditional diagnostic tools such as chest x-rays, lung biopsy, pulmonary function studies and immunologic testing may provide much more rapid and reliable answers.

Modern philosophy of science. In general, experimental methods are superior to non-experimental methods in discovering and establishing the existence of causal relationships.[8] The initial postulates of Koch were developed for the documentation of an infectious etiology or cause for diseases. The postulates stated:

> *The agent or organism occurs in every case of disease in circumstances which can account for the pathological changes in its clinical course. It occurs in no other disease as a fortuitous, non-pathogenic agent. After being fully isolated and separated from the body and repeatedly brought in for culture, it can induce the disease anew.*

Nevertheless, the postulates themselves still serve, in modified form, as the basis for scientific proof.[9] Implicit in the postulates is a pure experimental setting.

These concepts were expanded by Evans[10] into a "unified concept of causation" that encompasses the following 10 points:

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• The prevalence of disease should be significantly higher in exposed than in unexposed individuals.

• Exposure to the putative cause should be more common in individuals with disease than without.

• Incidence of disease should be higher in individuals with disease than without, in perspective studies.

• Disease should follow exposure to the putative agent, with a distribution of incubation or latency periods.

• A spectrum of host responses should follow exposure to the putative agent, along a biological gradient from mild to severe.

• A measurable host response should occur after exposure or increase presence before exposure.

• Experimental reproduction of disease should occur in animals or man after exposure to a greater degree than in those not exposed.

• Elimination and modification of the putative cause should decrease incidence of disease.

• Prevention or modification of the host's response to the cause should decrease or eliminate the disease.

• The relationship should be biologically and epidemiologically plausible.

Where no specific agent has been implicated, many of these criteria may not be fulfilled. Therefore, although experimental design always provides a more certain scientific answer than studies without an experimental component, we are frequently left without possible recourse to the Koch postulates. Molhave has summarized the evidence that low levels of VOCs are at least one potential cause of the sick building syndrome.[11]

Legal definitions of causal associations

In contrast to medical approaches to disease, legal approaches in building-related illness are based on the question of whether a disease can be attributed to a specific exposure or a specific building, so that a "wrong" can be righted. The goal is not necessarily to return an employee to gainful employment, to prevent disease or illness, or to solve a problem.

When presenting the facts of a case to a judge or jury, a lawyer must rely on the opinions of professionals with expertise in certain relevant areas. The usual approach is to inquire whether a physician or other expert considers that a medical condition is caused by a specific setting. The definition of causal relationships and the likelihood or probability of causation in the expert's mind become critical issues.

With our current legal system, the burden of proof is usually met in these cases when the evidence can demonstrate a 51% probability of an association. In fact, physicians do not necessarily distinguish between 51% or 50% or 52% probabilities, and admit that distinctions on that level are quite arbitrary.

(Workers compensation statutes vary from state to state, and will not be dealt with in this article. Readers are referred to local sources, such as occupational physicians or lawyers, for any questions.)

However, in many of these cases, lawyers are attempting to bring a legal action for negligence. Negligence has been defined as conduct that falls below the standard established by law for the protection of others against unreasonable risk of harm.[12] Negligence does not require either reckless or intentional behavior. Negligent conduct may consist either of an act or an omission. The former involves an unreasonable risk of harm. The latter consists of a failure to act for the protection or assistance of another when there is a duty to do so.[13]

There are four required elements of a cause of action for negligence. First, the defendant must have a legal duty to conform to a specific standard of conduct, so that the plaintiff is protected against an unreasonable risk of injury. Second, the defendant breaches this duty if the behavior in question is not in conformance with the required standard.

Third, the defendant's breach of duty must constitute the actual and proximate (legal) cause of the plaintiff's injury. Briefly, proximate or legal cause occurs when there are no unforeseeable, intervening or superseding events to break the natural and continuous chain of events from defendant's behavior to plaintiff's injury. Causation is as difficult an area in law as it is in medicine. Finally, a negligence action requires that the plaintiff suffered actual, measurable harm to himself or his property.

Generally, the questions asked are can the physician state "with reasonable medical certainty" that a specific effect results from a specific cause (in workers' compensation) or whether the relationship is "more probable than not" (civil litigation). These are not medical terms, and physicians are hard pressed to understand and explain their thought processes.

From a medical perspective, the severity of the illness, the ease and danger of making a diagnosis, and the hazard of the diagnostic procedure all enter into that opinion. Therefore, even a 30% chance of a specific disease may lead physicians to act on a hypothesis without further diagnostic measures. In this case, they may be "reasonably medically certain" if the potential disease is severe, the treatment harmless and the diagnostic test dangerous.

On the other hand, for trivial complaints with even a 60% likelihood of a causal relationship to a workplace, physicians may be generally unwilling to stake their professional reputation and expertise on a possibility that is not important.

Some abnormalities are clearly related to an occupational exposure, with changes in some measurable health outcome that allows linkage to a specific source. The ability to link a physiologic abnormality is essential to documenting causal associations in a scientific sense. The legal context in which these associations must be proven varies: workers compensation proceedings, arbitration or jury trials.

The scientific facts may be presented as evidence. However, other, non-scientific aspects may also be presented and these may not be credible from a strictly scientific view.

Causal associations of building-related illness

Each of the models developed above has been applied to specific cases of disease that were reported in the scientific literature. This section addresses some of the diseases seen from occupational exposures in buildings. Specific cases are also presented to document how the various techniques may be used.

Sick building syndrome. Over the last 15 years, various symptoms (headaches, fatigue, dizziness and eye, nose and throat irritations) have been seen with varying frequencies in office workers. Traditionally, these symptoms have not been considered as part of a disabling disease. Nevertheless, some office workers have complained severely about an inability to work.

There is some evidence that these complaints are related to low levels of VOCs, both from experimental chamber studies[11] and from field studies.[14] A few large-scale studies have been published[15] and demonstrated that the symptoms are more frequent in buildings with mechanical ventilation. However, there are generally no good, readily available clinical markers to distinguish sick from non-sick individuals.

These neurotoxic symptoms are consistent with Molhave's definitions of the sick building syndrome and represent abnormalities that are interpretable as resulting from VOC exposures. There is evidence from large-scale epidemiologic studies that these

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symptoms occur excessively in office workers in buildings with mechanical ventilation systems. In this case, there is adequate evidence to justify an administrative action to reassign the individual to a different workplace.

Legionnaire's disease. Between 50,000 to 70,000 cases of Legionnaire's disease are thought to occur each year in America, with about 15% ending in a fatality. The disease generally presents as a pneumonia. Individuals who develop the disease generally have some impairment of their defenses such as occurs with aging, lung disease (asthma or pulmonary disease from cigarette smoking) or suppression of the immune system. (The immune system recognizes and destroys foreign substances.)

Two modes of disease transmission have been identified. First, patients may inhale droplet aerosols, such as occur in cooling tower plumes. Second, they may drink water contaminated with *Legionnella*. In this case, the bacteria may colonize the patient's throat and the saliva may get into the trachea (aspiration). In the presence of impaired lung defenses, the bacteria cannot be coughed out or otherwise cleared from the lungs, resulting in pneumonia.

Up to half of the bodies of water in America are believed to contain *Legionnella* strains. Risk factors for the colonization of water systems have been recognized. These include the presence of electric water heaters in upright tanks, scale development, blind pipe ends and kinking of pipes. The disease is not rare, with about 5% of all pneumonias attributed to *Legionnella*.

Criteria for the diagnosis of work-related Legionnaire's disease include:

- A recent illness consistent with Legionnaire's disease;
- Blood testing or culture evidence of a recent infection with *Legionnella* bacteria; and
- Evidence for the same organism present in the workplace, but ideally not at home.[16]

Serologic evidence consists of either a four-fold increase in antibody titers to *Legionnella* strains or a single titer measurable in a dilution of greater than 1:256. (Titer is the concentration of a substance in solution.)

If true outbreaks are seen with many cases occurring at the same time (as occurred with the original Legionnaire's disease outbreak), then it is considered legitimate to attribute a diagnosis to a specific source even if no route of transmission or specific source may be identified. Where single, sporadic cases are seen, the same organisms must be identified in the human body and in the water source, meeting the above criteria.

Similar considerations apply to other diseases with well-defined clinical markers. For example, cases of asthma or hypersensitivity pneumonitis have been described and attributed to work in buildings on numerous occasions.[17] In general, such cases were convincing because tests were performed that clearly linked changes in lung function to presence at work in the building in question but not elsewhere.

Using animal data. Medical tests are not available to diagnose all health effects and attribute them to building use. Where groups of workers are seen with specific complaints and likely causes are identified, it is sometimes unethical to re-expose the workers. However, animals may be exposed. When documented exposure reproduces changes in animals that correspond to human complaints, convincing evidence may also accrue.

Although animal studies cannot be extrapolated to humans without questioning, the science of experimental toxicology is based on the assumption that some effects are similar in man and animals. For example, carpet shampoo had an irritating effect leading to a specific respiratory response in rodents. Although no humans were exposed and although rodent respiratory tracts are somewhat different from those of humans, the presence of respiratory irritation in rodents is presumptive evidence of an adverse effect.[18]

New diseases. When diseases have not been seen in specific environments, disease-exposure relationships become more controversial. Consequently, more innovative approaches must be used to determine whether the effect in question is actually attributable to the putative cause. If a specific disease is postulated, some defined bodily function can be identified that should change or become abnormal, if the disease is related to work. For example, pesticide poisoning is generally not thought to occur among office workers. However, outbreaks have been reported.[19]

Subsequent review of an EPA database revealed that hundreds of similar cases had been reported but never disseminated further.[20,21] In the presence of reports (albeit not published) and convincing biochemical evidence, this case was considered reasonably convincing.

As new syndromes are recognized or diseases associated with additional causes, similar descriptions linking them to the new inciting event will be published. These reports must be carefully scrutinized.

Conclusion

When physicians are faced with patient complaints, they may define a syndrome in pathophysiologic measures. They must then decide whether tests are necessary for a specific diagnosis and, at least as importantly, they must decide how good these tests are at determining the presence or absence of disease. If epidemiologic evidence is present, it may be inappropriate to perform tests only on an individual basis.

Depending on the degree of hazard, a new appropriate test may be developed. However, there must be some relationship between the degree of hazard in the test and the benefits of a diagnosis. In the absence of either demonstrated physiologic changes or epidemiologic studies that suggest the legitimacy of a certain symptom complex, it is difficult to make a convincing argument for action.

In an ideal setting, employees with a building-related illness may simply be reassigned to another environment. This could be even within the same building and even in the absence of rigorous documentation of the presence of a problem.

At times, employers fare better when reassigning employees to a more comfortable or healthy workplace because of the social and organizational dysfunction that may be induced by leaving a disgruntled, sick or unhappy employee in a specific setting. The economic trade-offs have been described in Woods.[22] ■

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